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GB 2347952 A GB 2347950 A GB 2344606 A
GB 1137310 A EP 0881354 A WO 99/35368 A
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US 4703959 A US 4648627 A US 4577895 A
US 4501443 A

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(74) continued overleaf

(54) Abstract Title
Wellbore casing with radially expanded liner extruded off of a mandrel

(57) An expandable threaded connection includes a first tubular member, a second tubular member and a threaded connection for coupling the tubular members that includes one or more sealing members.

This international application was published on 21 December 2000. The international search is not available and, therefore, the search incorporated into this document has been made under Section 17.

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GB 2 355 738 A

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Application No: GB 0016917.7
Claims searched: 1

Examiner: David Pepper
Date of search: 25 September 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): E1F FJT, FLA

Int Cl (Ed.7): E21B

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,E	GB 2347952 A	(Shell Int Research)	1
X,E	GB 2347950 A	(Shell Int Research)	1
X,E	GB 2344606 A	(Shell Int Research)	1
X	EP 0881354 A	(Sofitech N.V.)	1
X	WO 99/35368 A	(Shell Int Research) - see figure 4	1
X	WO 98/00626 A	(Shell Int Research)	1

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

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INVESTOR IN PEOPLE

Application No: GB 0016917.7
Claims searched: 43-52

Examiner: David Pepper
Date of search: 25 January 2001

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Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 1137310 A	(Commissariat a l'Energie Atomique)	-
A	US 5924745 A	(Petroline Wellsystems Ltd)	-
X	US 4707001 A	(Seal-Tech Inc) - see col 5, lines 9-37	43-45
X	US 4703959 A	(Hydril Co)	43-45
X	US 4648627 A	(Dril-Quip Inc) - see col 4, lines 25-39	43-45,47
X	US 4577895 A	(Hub City Works Inc) - see col 2, lines 40-54	43,44
A	US 4501443 A	(Mannesmann Aktiengesellschaft)	-

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

Application No: GB 0016917.7
Claims searched: 59-63

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UK Cl (Ed.S): E1F FLA

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Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A,P	GB 2344606 A (Shell Internationale Research Maatschappij B.V.)	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		

92, such as aluminum, for example. The outside diameter of the flared out segment **90** is still less than the inside diameter **96** of the casing **98**. Ultimately, the flared out portion **90** is to be expanded, as shown in Figure 21, into contact with the inside wall of the casing **98**. Since that distance representing that expansion cannot physically be accomplished by the upper end **96** because of its placement below the flared out portion **90**, the sleeve **94** is employed to transfer the radially expanding force to make initial contact with the inner wall of casing **98**. The upper end **86** of the swage assembly **84** has the shape shown in Figure 22 so that several sections **100** of the tubular **92** will be forced against the casing **98**, leaving longitudinal gaps **102** for passage of cement. In the position shown in Figures 21 and 22, the passages **102** are in position and the sections **100** which have been forced against the casing **98** fully support the tubular **92**. At the conclusion of the cementing operation, the lower segment **88** comes into contact with sleeve **94**. The shape of lower end **88** is such so as to fully round out the flared out portion **90** by engaging mid-points **104** of the flared out portion **90** (see Figure 22) such that the passages **102** are eliminated as the sleeve **94** and the flared out portion **90** are in tandem pressed in a manner to fully round them, leaving the flared out portion **90** rigidly against the inside wall of the casing **98**. This is shown in Figure 23. Figure 25 illustrates the removal of the swage assembly **84** and the tubular **92** fully engaged and cemented to the casing **98** so that further completion operations can take place. Figures 24 and 26 fully illustrate the flared out portion **90** pushed hard against the casing **98**. Again, in this embodiment as in all the others, auxiliary sealing devices can be used be-

tween the tubular **92** and the casing **98** and the process is done in a single trip.

Referring now to Figures 27–30, yet another embodiment is illustrated. Again, the similarities in the running in procedure will not be repeated because they are identical to the previously described embodiments. In this situation, the tubular **106** is initially formed with a flared out section **108**. The diameter of the outer surface **110** is initially produced to be the finished diameter desired for support of the tubular **106** in a casing **112** (see Figure 28) in which it is to be inserted. However, prior to the insertion into the casing **112** and as shown in Figure 28, the flared out section **108** is corrugated to reduce its outside diameter so that it can run through the inside diameter of the casing **112**. The manner of corrugation or other diameter-reducing technique can be any one of a variety of different ways so long as the overall profile is such that it will pass through the casing **112**. Using a swage assembly of the type previously described, which is in a shape conforming to the corrugations illustrated in Figure 28 but tapered to a somewhat larger dimension, the shape shown in Figure 29 is attained. The shape in Figure 29 is similar to that in Figure 28 except that the overall dimensions have been increased to the point that there are locations **114** in contact with the casing **112**. These longitudinal contacts in several locations, as shown in Figure 29, fully support the tubular **106** in the casing **112** and leave passages **116** for the flow of cement. The swage assembly can be akin to that used in Figures 5–11 in the sense that the corrugated shape now in contact with the casing **112** shown in Figures 29 at locations **114** can be made into a round shape at the conclusion of the cementing operation. Thus, a second portion of the swage assembly as

previously described is used to contact the flared out portion **108** in the areas where it is still bent, defining passages **116**, to push those radially outwardly until a perfect full 360° contact is achieved between the flared out section **108** and the casing **112**, as shown in Figure 30. This is all done in a single trip.

Those skilled in the art can readily appreciate that various embodiments have been disclosed which allow a tubular, such as **10**, to be suspended in a running assembly. The running assembly is of a known design and has the capability not only of supporting the tubular for run-in but also to actuate a swage assembly of the type shown, for example, in Figure 1 as item **16**. What is common to all these techniques is that the tubular is first made to be supported by the casing due to a physical expansion technique. The cementing takes place next and the cementing passages are then closed off. Since it is important to allow passages for the flow of cement, the apparatus of the present invention, in its various embodiments, provides a technique which allows this to happen with the tubular supported while subsequently closing them off. The technique can work with a swage assembly which is moved downwardly into the top end of the tubular or in another embodiment, such as shown in Figures 20-26, the swage assembly is moved upwardly, out of the top end of the tubular. The creation of passages for the cement, such as **34** in Figure 8, **76** in Figure 17A, or **102** in Figure 22, can be accomplished in a variety of ways. The nature of the initial contact used to support the tubular in the casing can vary. Thus, although four locations are illustrated for the initial support contact in Figure 8, a different number of such locations can be used. Different materials can be used to encase the liner up

and into the casing from which it is suspended, including cement, blast furnace slag, or other materials. Known techniques are used for operating the sliding sleeve valve shown in Figure 12-15, which selectively exposes the openings **50**. Other types of known valve assemblies are also contemplated. Despite the variations, the technique winds up being a one-trip operation.

Those skilled in the art will now appreciate that what has been disclosed is a method which can completely replace known liner hangers and allows for sealing and suspension of tubulars in larger tubulars, with the flexibility of cementing or otherwise encasing the inserted tubular into the larger tubular.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made.

Claims

1. A method of completing a well, comprising:

running in a tubular string into a cased borehole;

expanding a portion of said tubular into supporting contact with the casing;

delivering a sealing material through at least one opening in said tubular, with said tubular so supported;

closing off said opening.

2. The method of claim 1, further comprising:

expanding said tubular to accomplish said closure after said delivering of said sealing material.

3. The method of claim 2, further comprising:

using said expanding to close off said opening to accomplish a seal between said tubular and said casing.

4. The method of claim 3, further comprising:

providing a seal downhole of said opening as a backup seal to any seal formed by said expanding.

5. The method of claim 1, further comprising:

pushing said opening against the casing to close it.

6. The method of claim 2, further comprising:

accomplishing said running in, supporting, delivering a sealing material, and closing of said opening by expansion, all in a single trip into the well.

7. A method of completing a well, comprising:

running a tubular string into a cased borehole;

expanding portions of said tubular string into

contact with the casing for support thereof;

leaving gaps between said tubular string and said casing, with said tubular string supported to said casing;

using said gaps for passage of a sealing material;

closing said gaps.

8. The method of claim 7, further comprising:

providing longitudinal contact between said tubular string and said cased borehole;

defining said gaps as passages between said longitudinal contacts between said tubular string and said cased wellbore.

9. The method of claim 8, further comprising:

using a fluted expansion swage to create said longitudinal contact for support of said tubular string;

providing offset flutes on said swage, located one above another;

using lowermost flutes to create said longitudinal contact;

using offset flutes to subsequently remove said gaps after passage of said sealing material.

10. The method of claim 9, further comprising:

offsetting said offset flutes about 90° from said lowermost flutes.

11. The method of claim 7, further comprising:

accomplishing said running in, expanding, leaving gaps, passage of said sealing material, and closing said gaps in a single trip into the wellbore.

12. The method of claim 7, further comprising:

providing a seal between said tubular string and said cased borehole by said closing of said gaps.

13. The method of claim 1, further comprising: using full circumferential contact for said supporting contact.

14. The method of claim 13, further comprising: providing a valve with said opening; operating said valve to close off said opening.

15. The method of claim 14, further comprising: providing a sliding sleeve on said tubular string as said valve.

16. The method of claim 7, further comprising: running in with a swage inside said tubular string; supporting said tubular string while moving said swage uphole to expand portions of said tubular string into contact with said cased borehole for support thereof.

17. The method of claim 16, further comprising: locating a force transfer member inside said tubular string during run-in; transferring an expansion force from said swage through said force transfer member to said tubular string for said expansion into said cased borehole for support thereof.

18. The method of claim 17, further comprising: configuring said swage to force said gaps closing through a force transfer through a sleeve which serves as said force transfer member.

19. The method of claim 9, further comprising: running in with a swage inside said tubular string; supporting said tubular string while moving said swage uphole to expand portions of said tubular string into contact with said cased borehole for support

thereof.

20. The method of claim 19, further comprising:

locating a force transfer member inside said tubular string during run-in;

transferring an expansion force from said swage through said force transfer member to said tubular string for said expansion into said cased borehole for support thereof.

21. The method of claim 20, further comprising:

configuring said swage to force said gaps closed through a force transfer through a sleeve which serves as said force transfer member.

22. The method of claim 7, further comprising:

reducing the diameter of a part of a tubing string whose original dimension, on said part thereof, was at least as large as the inside diameter of a cased wellbore, to an outer dimension small enough to fit into said cased borehole.

23. The method of claim 22, further comprising:

expanding said portion of said tubing string to its said original dimension to close said gaps;

providing said original dimension as larger than the inside dimension of said cased wellbore;

sealing between said tubing string and said cased wellbore by forcing said portion of said tubular string into circumferential contact with said cased wellbore.